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Empowering information and communication technologies in isolated areas: learning from the solar-net villages program in honduras

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Abstract

To reduce poverty caused by inequality of opportunities in isolated areas, many developing countries are now taking advantage of recent technical advances in information and communication technologies (ICTs) to enable the remote populations to enjoy the benefits of improved commerce, education, health, and other social services. This paper describes lessons learned from the Solar-Net Villages Program (or Aldeas Solares) of Honduras with respect to its early attempts to find technological solutions for providing ICT services to isolated areas and the government's ongoing efforts to balance the objective of assisting the most disadvantaged populations with the need to have sustainable services.

Keywords: Information and communication technologies (ICTs); Energy services; Solar energy systems; Isolated areas; Telecenter; Operational sustainability

Contents

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1. Introduction

Populations in isolated areas are traditionally disadvantaged and unable to break out of the vicious cycle of poverty because they lack basic services and information available to other dwellers in less-remote areas. Many developing countries are now taking advantage of recent technical advances in information and communication technologies (ICTs) to enable these remote populations to enjoy the benefits of improved commerce, education, health, and other social services. The Government of Honduras (GOH) considers as high priority the promotion of accessibility and effective usage of basic energy services for information, communication, health, and education. The objective is to reduce the inequality of opportunities, a main cause of poverty. Consistent with this objective, the Solar-Net Villages Program (or Aldeas Solares) was developed under the leadership of the *Centro Hondureño de Ciencia y Tecnología* (COHCIT).

The Energy Sector Management Assistance Program (ESMAP), managed by the World Bank, recently assisted the GOH in addressing the special problems posed by un-electrified areas remote from the grid. Provision of even basic ICT services requires power. Remote power systems, such as photo-voltaics (PV), need to be designed to provide sufficient power at minimum cost, considering the scarcity of financial resources in these areas. In collaboration with COHCIT, the International Telecommunications Union (ITU) and Hondutel, two remote telecenters were established partly with ESMAP funds to test wireless Internet access powered by stand-alone systems and obtain experience and data on operations and costs. An important objective was to help develop criteria for selection of isolated sites to be included under a broader *Aldeas Solares* program financed by the InterAmerican Development Bank (IADB). The $9.5 million program aims to establish telecenters in about 1000 villages in Honduras, some of them located in un-electrified areas far from the grid.

This paper describes lessons learned from the *Aldeas Solares* program of Honduras with respect to its early attempts to find technological solutions for providing ICT

services to isolated areas and the government's ongoing efforts to balance the objective of assisting the most disadvantaged populations with the need to have sustainable services.

2. Early attempts: the san ramon solar-net demonstration project

The Program was initially called 'Solar Village Program', which was conceived by the government as a means to provide basic energy services to schools, clinics and other communal centers in remote, un-electrified communities through solar energy systems, mainly photovoltaic (PV) systems. With initial financial assistance from United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Organization of American States (OAS), two 'solar villages' were created, the first in San Ramon, Choluteca in July 1999 and the other in San Francisco, Lempira in May 2000. After obtaining support from the Utah-based OnSat Network Communications, it was decided in mid-2000 to shift the Program's objectives from just merely providing solar power to community centers in remote areas towards 'bridging the digital divide' through access to telecommunications and the Internet. The new goal was to improve learning conditions of school children and adults, improve marketing opportunities of existing local micro-enterprises through access to online business information and even stimulate the creation of new micro-enterprises.

San Ramon is an isolated village of about 850 inhabitants or about 150 households in the Southern part of Honduras. Although not too far from the town of Choluteca, physical access is extremely difficult because of its elevation and very poor condition of the pathways. For this reason and the low population density, there are no connections to the electricity grid and the main telephone lines. At the time that the village was selected as a pilot site, a primary school that doubles as a community center served a student population of 213. There were four teachers. A health center attended by one nurse provided basic health services and emergency assistance. The clinic had a kerosene-powered refrigerator. The water source was a small dam, locally built, which was distributed through a network coordinated by a local water committee. The climate was dry and hot and crops were often grown in dangerous, steep areas.

COHCIT's original objective in San Ramon was to demonstrate the use of photovoltaic systems to provide lighting to the school and clinic, power for a videocassette recorder and a TV set for educational purposes, power for a small medical refrigerator in the clinic, and hot water in the clinic through a solar water heater. The project cost of US$250,000 included the solar power system, solar water heater, physical improvements and equipment for the school building and health center. The installed PV capacity was 2.2 peak kilowatts.

The later collaboration with OnSat added telecommunications services, including a telephone, computers (donated by Gateway) and broadband access to the Internet via a parabolic antennae and satellite reception equipment donated by OnSat.

3. Results and lessons learned

Observations made several months after installations clearly showed the impact of the solar energy systems. PV-generated electricity enabled schoolchildren and residents to enjoy the videocassette and TV equipment. The PV-powered street lights improved the community's social life and perception of safety. School and health center facilities could now be used at night. The PV-powered small refrigerator and solar water heater at the health center noticeably improved services provided by the clinic.

Access to computers and the Internet had the most immediate impact on the school children. Interest in doing education-related tasks were increased by a variety of learning software and the Internet itself. Some adults also quickly became proficient in some of the business software that were made available, although the practical application of the new found skills were not apparent in most cases. Surveys made by COHCIT indicated that, in general, the project instilled a deeper sense of participation by residents in community pursuits as well as a desire to use the new facilities for economic improvement.

The evidence on economic benefits, however, is still largely missing. There has not been any tangible proof of the envisioned downstream benefits of connectivity, such access to wider markets by existing local enterprises and creation of new IT-based economic activities. COHCIT summarized the lessons learned from the San Ramon experience as follows [1]:

(a) The goal of participation of local micro-enterprises in wider markets was not adequately supported. Technical assistance to the micro-enterprises was utilized only to improve local supply and demand of products and hence kept the businesses at the subsistence level. It proved difficult to create links to bigger communities and development poles. A key reason in the case of San Ramon is the absence of basic road infrastructure to get raw materials in and products out.
(b) The costs of sustaining the operation of the PV systems are still unknown and have not been planned for. While the pilot was initiated due to funding by international donors and collaborators, the cost of operation and maintenance must now be borne by the national and/or local governments in order to continue. Availability of such resources is doubtful.
(c) The inter-institutional coordination mechanism was ineffective and the full potential of the pilot demonstration was not realized.

The most intractable aspect was clearly the cost. The parabolic satellite antennae alone, donated by OnSat, costs about $250,000. Satellite access was also being provided for free for the pilot but could normally cost as high as $5 per minute. It was highly doubtful if local usage of the ICT facilities during normal operation would be able to support the costs of operation and maintenance, let alone recoup part of the capital costs. There was no question that the San Ramon investments were not replicable.

A final lesson is perhaps the most crucial one: the pilot villages, including San Ramon, were chosen based on UN indices for poverty and underdevelopment. Thus, in general, the originally chosen areas for *Aldeas Solares* had low literacy rates and hence low potential for entrepreneurial development, had very low incomes and ability to pay for services,

and were highly unlikely to have any existing viable enterprises. There was thus an inherent conflict between the desire to have sustainable services with the desire to target 'the poorest and the remotest' communities.

4. Towards a sustainable expansion plan

4.1. The IADB-financed project

In October 2001, the InterAmerican Development Bank (IADB) approved an US$8.5 million loan by the Government of Honduras for the COHCIT program. The plan was to expand the program to at least 1000 villages, with the first step expansion targeting 100 villages. The total project cost is $9.5 million, with $1 million as GOH counterpart. The IADB-financed project entitled 'Expansion of Technological Capacities in Poor Communities' had the broad objective of reducing poverty related to the disadvantages of isolation and unequal opportunity experienced by poor communities. The specific objectives were: (a) to confirm the technical viability and cost-effectiveness of a model for delivering a set of technological tools to provide educational and market-knowledge services in a sample of communities; and (b) to provide institutional strengthening for COHCIT to accomplish its mission of coordinating technological exchanges that seek to promote the development of poor communities. The 'technology package' to be financed would consist of rural telecenters and associated equipment and content materials, including renewable energy power systems, as needed.

Although the project agreement is not restrictive on the location of the demonstration sites to be selected, COHCIT recognized, as a result of the San Ramon experience, that in order to maximize chances for operational sustainability, the majority of the rural telecenters would need to be in areas where potential clients have a minimum critical mass and the ability to pay for the ICT services. This implies sites that are not remotely located and consequently may already be connected to the electric grid.[1] Again, this illustrates the dilemma faced by COHCIT and the GOH.

4.2. An alternative to satellite-based Internet access

As learned from the San Ramon experience, a less costly alternative to satellite-based Internet access must be found for poor, remote villages. One way is through wireless radio. There are currently 17 existing Internet Service Providers (ISP) in Honduras. Within their area of coverage, which include cities and towns located in a band running across Tegucigalpa from South to North, as well as in a band in the Northern portion of the country, it is possible to connect with these ISPs by landline. An urban-based telecenter that is connected by landline to an ISP could serve as a gateway to bring Internet

[1] The 'Solar-Net' label for the program is therefore, a misnomer because majority of the sites are likely to be grid-connected and will not need stand-alone solar power systems.

and telephone services to surrounding remote villages up to 100 km away via relatively inexpensive packet-radio links.

The International Telecommunications Union (ITU), the eventual main collaborator of the ESMAP activity, has been piloting this approach in Honduras and considers that an urban telecenter can feasibly link with 8–10 remote centers. The needed investments for the radio link are for a radio-modem (TNC or terminal node controller type) and radio equipment at each end, at a cost of about $700–800 (assuming line-of-sight). There is no additional cost for Internet usage at the remote end. If the remote end is un-electrified, investment in a stand-alone power supply (such as a PV system) would be needed.

5. Objectives and status of the ESMAP assistance

Support for this idea was, in fact, the core of the ESMAP technical assistance activity. ESMAP's expertise is in the field of energy, not telecommunications. ESMAP's assistance to clients on energy matters has always been not for the sake of energy itself but for its important linkages to economic development and the improvement of quality of life of people, particularly the poor and those in remote, rural areas. As officially requested by COHCIT, ESMAP assistance to the *Aldeas Solares* or Solar-Net program consisted of the following:

(a) Technical design, financing and installation of the solar power supply systems for two demonstration remote telecenters;
(b) Financing and installation of computers and peripheral equipment for the two remote telecenters;
(c) Training/workshop on remote PV systems design and maintenance;
(d) Livelihood and micro-enterprise evaluation studies for two villages; and
(e) Organization and training of local operators and managers of the remote telecenters.

The two pilot sites selected by COHCIT were the villages of La Montaña Grande and Las Trojes, both located in the National Park La Tigra, about 30 km from Tegucigalpa. With the collaboration of Hondutel, ITU had earlier identified and started radio equipment installation at the two villages. The plan was to link La Montaña Grande by radio to an urban telecenter in Valle de Angeles, while Las Trojes would be linked to an urban telecenter in Santa Lucia. Both villages were, at the time, un-electrified. Internet access would be provided to the two rural villages via packet radio links.

6. Status

Las Trojes unexpectedly obtained grid connection as the remote power system was being designed. Only La Montaña Grande was therefore provided a solar power supply system. Both were provided computers and basic office furniture and equipment. All telecommunications equipment and accessories were provided by the collaborators, International Telecommunications Union (ITU) and Hondutel. For La Montaña Grande, it was decided to use more

expensive laptops than desktop computers. The much lower energy needs of the laptops meant less PV power, and hence lower overall cost [2]. Similarly, less power-consuming LED lights were provided. Conventional lighting and desktop computers were provided to Las Trojes due to the grid connection. A collaborator, Sandia Laboratories, contributed its expertise on stand-alone PV power systems. Access to the internet in both rural telecenters via radio links was achieved and both remote power and ICT systems are now fully functional. To ensure sustainable operation and maintenance of the rural telecenters, local community groups were organized and trained [3].

La Montaña Grande was formally inaugurated and turned over to the community during a dissemination workshop held in November 2003 in Santa Lucia (where the telecenter linking to the La Montaña Grande rural telecenter is located). The next 6–8 months of operation of the new rural telecenters will be carefully monitored by COHCIT, in accordance with a monitoring and evaluation plan agreed with ESMAP. The main purpose is to collect hard data and information on actual usage and operating costs of the rural telecenters, to determine if they could be sustained without substantial subsidies. The immediate objective is to provide input into the selection of additional rural sites for the broader *Aldeas Solares* program financed by the IDB.

7. Some conclusions

There is no question that remote communities benefit from the provision of even the most basic ICT services with stand-alone power. Las Trojes and La Montaña Grande were clearly revitalized by the small pilot assistance that was provided by ESMAP and its collaborators. Those involved in the small flower industry La Montaña Grande, for example, are now contemplating expanded marketing via the internet. In un-electrified La Montaña Grande, the introduction of PV power has led to plans for a community-operated movie business-showing of VHS movies in the school TV at night with admission fees charged. In both communities, the schoolchildren appear to be the main beneficiaries, judging by their rapid acceptance of the use of computers and the internet. What remains to be assessed is whether the operation of these remote rural tele-centers can be financially and technically sustained.

As already mentioned, there is an inherent conflict between the sustainability objective and the desire to assist those that are most in need the poor, disadvantaged and un-electrified communities in the country. What is likely to emerge in the case of the Honduras pilots and similar remotely located installations is that significant subsidies from the government that would be needed to sustain operation and services. In other words, establishment and operation of tele-centers in marginal areas have to be treated as social investment projects with subsidies justified on equity grounds. The question for government then is how to prioritize its various social projects for disadvantaged communities, given finite public resources.

When the policy decision is made to provide ICT services to the poor in un-electrifed remote areas, it is clear that the least cost and most efficient approaches and technologies must be used in order to do more with same amount of resources. This is what ESMAP and its collaborators have tried to do in the case of the Aldeas Solares Program of Honduras.

References

[1] Consejo Hondureño de Ciencia y Tecnología, Ampliación de Capacidades Tecnológicas en Comunidades Pobres, Project Report to ESMAP; 2003.
[2] Foster R, Especificaciones Generales para Sistemas de Energia FV en Telecentros, Southwest Technology Development Institute, New México State University; 2002.
[3] Posas C, Plan Estratégico del Centro Comunitario de Conocimiento y Comunicación de la Comunidad de Las Trojas, Report to COHCIT; 2004.